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IN TWO SECTIONS

## Section I

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## EDITORIAL DEPARTMENT NOTE

One of the principal justifications for N. A. C. A. publications is the great variety of cost accounting procedures which are necessary to properly account for the costs in the great variety of production methods found in American industry. Concerns in the same industry have different production methods and therefore, different problems in costing. As between different industries the types of costing are so numerous that only the broadest general principles are applicable to all. This is undoubtedly the reason why the various case studies published in the N. A. C. A. Bulletin have proven so popular. The problem in cost accounting for a particular manufacturing concern is not so much a problem of following general principles as it is a problem of applying these principles to a specific situation. Case studies outlining methods followed in a particular company appeal to our readers because they report in a specific way the method used under a specific set of conditions. In this way we gain experience—second-hand rather than practical experience, but experience none the less. The two case studies in this issue of the Bulletin will help you to add to your second-hand experience regarding two industries which have their own production and cost problems.

The first article is by a charter member and Past-President of our Hartford Chapter. Carl L. Seeber gained his early business experience with an Atlantic City newspaper, starting as office boy and advancing through the circulation and bookkeeping departments to Advertising Manager. Later, while employed as Cashier at a beach front hotel, he continued his study of accounting, and in 1915 entered the Wallace Barnes Co. as Assistant to the Chief Accountant. He has advanced through the positions of Cost Accountant and Assistant Controller to his present position of Assistant Treasurer and Member of the Board of Directors. He is also a Director of the local Chamber of Commerce and Chairman of its Finance Committee. Mr. Seeber was President of our Hartford Chapter in 1935-36.

The author of our second article is L. C. Mallet, Assistant Secretary and Auditor of the Sikorsky Aircraft Division of the United Aircraft Mfg. Corp. He has had broad experience in the airplane industry, having been connected formerly with the General Airplane Corp. of Buffalo in the capacity of Chief Cost Accountant, and also as Chief Cost Accountant with the Fairchild Aeroplane Mfg. Corp. at Farmingdale, Long Island. Mr. Mallet is a member of our Bridgeport Chapter.

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JUNE 15, 1937

# A COST SYSTEM IN A JOB ORDER PLANT

**By Carl L. Seeber, Assistant Treasurer,**
**Wallace Barnes Co. Division, Associated Spring Corp.**
**Bristol, Conn.**

THE WALLACE BARNES COMPANY is engaged in the manufacture of springs and the rolling of steel. With the exception of our rolling mill, we are entirely a job order plant. We make absolutely nothing for stock and every order is made up either to blue print, to specifications or to sample. These springs are used in every conceivable mechanical device, many of which we know nothing of. Our problem is to see that each customer gets what he wants at a reasonable price, but one which will show a fair margin of profit. Competition sees to it that our prices are reasonable but we must look out for the profit ourselves.

At our rolling mill we do make steel for stock in order to meet quick delivery and satisfy our customers' demands. We roll steel to several standard widths and thicknesses at which size it is held for production requirements when it will either be rolled to thinner gauges or slit and filed to narrower widths or sometimes hardened and tempered.

*Early and Recent History*

The Wallace Barnes Company was established in 1857 by Wallace Barnes, grandfather of the present owners. I am told that in the beginning the chief item of production was the "hoop spring" which was used for expanding the crinoline skirts which were the fashion of that day. The story goes that a barrel of these hoop springs would be made and some one would travel with them to New York by boat, sit on the barrel at the dock until he could find a buyer and then return to Bristol to make up another lot.

By contrast, in the year 1936 we entered a little more than 35,000 orders ranging in quantity from one spring to ten million springs and in value from $1.50 to $50,000 per order. We shipped 6,500,000 pounds of strip steel and 7,000,000 pounds of springs. These springs varied from one-tenth of an ounce per thousand to as high as fifty pounds per spring and in exceptional cases, even higher. Our plant covers about 365,000 square feet

and we employ approximately 1,200 men and women. We design and make our own production tools and in many cases build our own spring-making machines.

Cost accounting with us has progressed in very much the same manner. From no cost system at all, to a system of pencil notations on the back of a work card, through various stages until we reached our present system which gives us a very comprehensive picture of what has transpired during the process of manufacture.

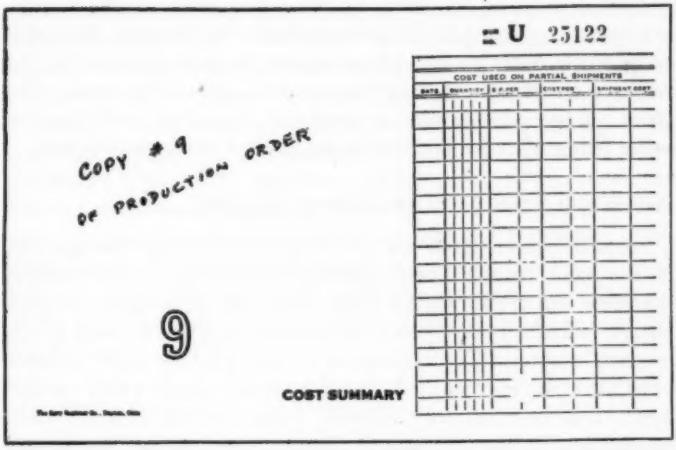
I will try to follow our procedure from the time an inquiry is received for a price quotation until the order is shipped, costed and filed, and I hope in this way to bring to you as complete a story as possible. Of course the space alloted for this paper will not permit me to go very much into detail, so we must of necessity skim the surface.

*Estimating Cost to Manufacture*

The request for a quotation is first delivered to our estimating and planning department where it is numbered and recorded. The manufacturing procedure is then outlined and the estimator, working with the divisional superintendent, builds up the cost to manufacture. The estimate is then delivered to the sales department for quotation, after which it is filed to await further instructions from our customer. All estimates must be in and out of our planning department within twenty-four hours or a reasonable excuse for the delay given. We keep a record and report monthly the total sales value of all estimates made as compared to new orders received from estimates. We also make an attempt to follow up any worthwhile estimate on which we have not received an order within a reasonable time.

*The Production Order*

The order when received is given a production number and listed numerically in an order record book for ready reference. The production orders, which contain a complete description of the springs to be made, together with the operations required and estimated quantities to be produced per hour, are made out in nine copies at one writing on a flat bed machine and include production copies, work card, cost summary card, analysis sheets for accu-


U 25122
COST USED ON PARTIAL SHIPMENTS
DATE
QUANTITY
$ P. PER
COST PER
SHIPMENT COST
COPY # 9
OF PRODUCTION ORDER
9
COST SUMMARY

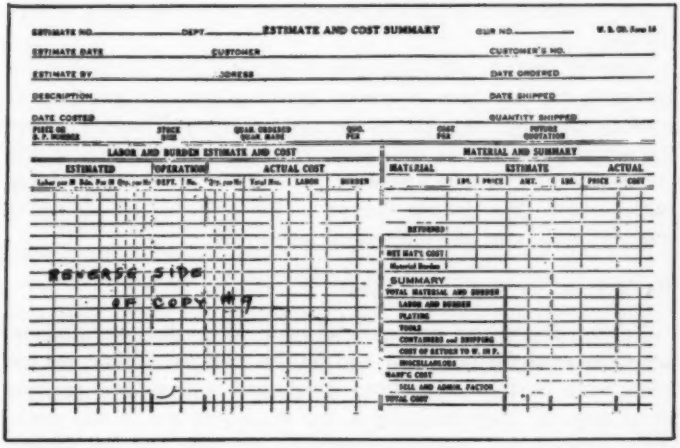

ESTIMATE AND COST SUMMARY
ESTIMATE NO.
DEPT.
ORD NO.
ESTIMATE DATE
CUSTOMER
CUSTOMER'S NO.
ESTIMATE BY
ADDRESS
DATE ORDERED
DESCRIPTION
DATE SHIPPED
DATE COSTED
QUANTITY SHIPPED
PIECE OR A. P. NUMBER
STOCK SIZE
QUAN. ORDERED QUAN. MADE
QUAN. PER
COST PER
FUTURE QUOTATION
LABOR AND BURDEN ESTIMATE AND COST
ESTIMATED
OPERATION
ACTUAL COST
DEPT.
LABOR
BURDEN
REVERSE SIDE
OF COPY #9
MATERIAL AND SUMMARY
MATERIAL
ESTIMATE
ACTUAL
LBS.
PRICE
AMT.
LBS.
PRICE
COST
RETURNED
NET MAT'L COST
Material Burden
SUMMARY
TOTAL MATERIAL AND BURDEN
LABOR AND BURDEN
PLATING
TOOLS
CONTAINERS and SHIPPING
COST OF RETURN TO W. IN P.
MISCELLANEOUS
MANF'S. COST
SELL AND ADMIN. FACTOR
TOTAL COST

EXHIBIT 1

mulating the productive labor and burden, etc. Copy 9, the Cost Summary is shown as Exhibit 1.

The foreman, upon receipt of the order, even though he may not be able to proceed with the manufacturing for some time, will immediately make his requisition against the order number for the required amount of stock and forward the same to the stock room clerk. If the stock is not on hand the stock clerk will place an order either with the purchasing department or the rolling mill.

*Accounting for Material and Material Burden*

Requisitions for stock are priced and extended at average cost in the stock room on perpetual inventory cards by bookkeeping machines and are forwarded daily to the cost department where a charge is made to the work-in-process account and a credit to the material account. The requisition is then filed by order number until the order is completed. Stock inventory cards which number approximately 6,000 are constantly being checked with the stock on the floor so that the pounds shown are reasonably correct and a new average price is figured on each card whenever stock is purchased.

Material burden which includes a share of the purchasing department expense plus receiving, handling and charges for inventory shrinkage, is added to the cost on a pound basis. We use the pound basis for this application because we do not think it will cost any more to handle a pound of aluminum than a pound of low carbon steel. We do not believe in the principle of adding to manufacturing cost any interest on investment.

*Problem in Accounting for Labor*

Having disposed of material and material burden, we will now try to account for our labor and burden charges. While we use piece work on those operations which can be done in a cut and dried way, the large majority of our employees are on day work. This includes tool makers, machinists, machine and die setters, hardeners, testers, inspectors and many spring makers. These men have to use their brains as well as their hands; their work cannot be measured because of its special features and the unusual character of the materials which they use.

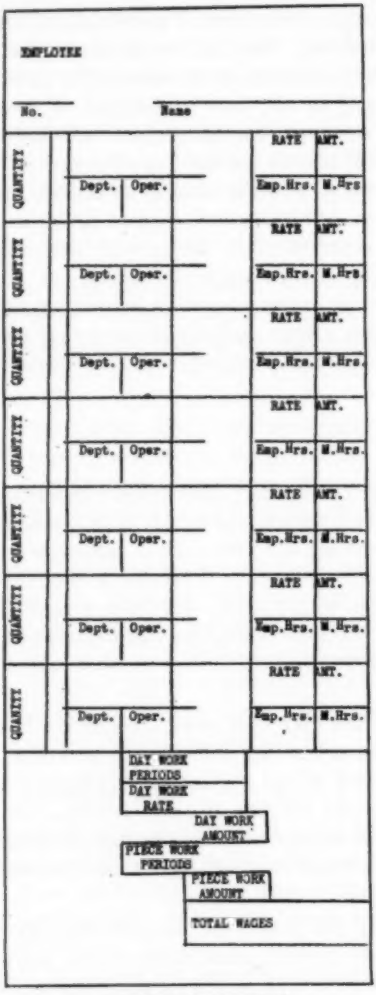
The usual manufacturing business can be engineered in advance, so that the function of the plant is merely to perform a set of predetermined operations. Our business is one which, on account of its infinite variety and unusual manufacturing problems, has to be engineered largely by the man in charge and, in many cases, by the producing workman himself. It will be self-evident then that we have no exact unit or standard of efficiency, nor do any of the so-called "efficiency" systems seem to be entirely applicable to our problems. If you will remember, I stated earlier in this paper that the divisional superintendent works with the estimating department in building up the original estimate for quotation. Even though we exercise every precaution in building this original estimate, we find that a large majority of our orders require additional study and experimental work before we are ready to proceed with production.

*Accounting for Labor*

We are using the duplicate labor ticket (illustrated in Exhibit 2) which folds over a carbon and which is so arranged that any employee can report six different jobs or operations within any one day. Any employee who finds it necessary to report more than six different changes within a day will have a second ticket started. The original or top copy is used for cost purposes and the duplicate becomes our payroll record. A new ticket is started for each employee daily.

Timekeepers are furnished with a combined labor and burden rate for each burden center and as soon as a job or operation is completed the cost of the elapsed time is figured and entered on the labor ticket. In the case of piece workers, the cost is figured at the piecework rate per hundred or per thousand and the burden for this piecework is added by the cost department when the order is completed.

Each morning the tickets for the previous day are torn apart and the duplicate is sent immediately to the payroll department where it is entered to the credit of the employee on our payroll books. These payroll books contain a sheet for each employee and these sheets have space for an entire year's earnings by days. As we have used these forms for several years, we did not find it




TIMETICKET (IN DUPLICATE)

EXHIBIT 2

necessary to make any changes to take care of social security deductions except to add an extra column to record these deductions.

*The Cost Analysis Sheet*

After sending the duplicate time tickets to the payroll department, the timekeepers send the original to the divisional posting clerks where the cost of performing the various operations is posted to an original and duplicate cost analysis sheet. These cost analysis copies are so valuable and necessary to us that I must pause here and elaborate on their uses.

The posting clerk will record the production department number, the operation, the employee number, machine or furnace number, the time consumed and the labor and burden cost. Our posting machines are of the flat bed type and are equipped with carbon rolls. In addition to posting to the cost analysis copies we receive a proof sheet or summary of a day's posting and this becomes the credit to the department for its day's production, the entry being: debit work in process, credit operating department.

These cost analysis copies remain in the live files of the divisional superintendent until the order is completed and are constantly referred to by the foremen who can tell at a glance which operations have been performed and whether the operators are meeting the estimated quantity per hour. The production department also uses these copies in checking through on their promised shipping dates.

A further use of these live cost analysis copies is made at inventory time. In taking an inventory of work is process it is only necessary to add the cost of the operations to date plus the material requisitioned and shipping containers used on partial shipments less the cost applied to partial shipments and we have the value of our goods in process as close as it would be possible to price any physical inventory.

*Shipping and Billing*

At the completion of an order the original is sent to the cost department for summarizing and the duplicate stays with the superintendent for his guidance on future or repeat orders. The work card remains with the job until the order is completed, when it travels to the shipping room where the shipping clerk attaches his

shipping copy and forwards both copies to the billing department. If a partial shipment is made, this lot will travel to the shipping department on a move ticket and the shipping clerk will make out what we call a "Partial Shipment Slip" which will be sent to the billing department.

Invoices are made out in triplicate and the third copy is passed on to the cost department for every shipment made on which we enter the cost to manufacture. When the invoice is for an entire shipment it is very simple to apply the cost as we find it, but when it is for a partial shipment a little more work is necessary. On applying the cost to a partial shipment we refer to the original estimate, or if the springs have been made before, we refer to the previous cost. If the order should be of large enough quantity, we will confer with the superintendent to ascertain whether we are meeting our estimated production before applying this partial shipment cost. Any cost which we apply to a partial shipment is entered on the reverse side of the cost card so that when the order is shipped complete we are able to adjust the costs applied to our actual completed cost.

Large customers are given a code number and at the end of each month the invoices for the month are assorted by customer's number and we furnish the sales department with a tabulation of sales and cost of sales by customers. We also tabulate our sales and cost of sales by divisions—flat, wire, steel, etc., and by types or classes such as—automobile, hardware, radio, etc.

*Three Divisions of Cost Department*

I will divide our cost department into three groups although they are all managed by our cost accountant.

The first group deals entirely with labor. They receive the cost copies of the duplicate labor tickets after they have been posted in the factory to job numbers, together with the proof sheet of daily postings and by means of a peg board system (See Exhibit 3) they charge each department with its share of the labor and credit each for the labor and burden absorbed on production. They accumulate daily the day work and piece work both male and female and their distribution of payroll must agree every day with the pay credited to the employees' accounts in the payroll department. Indirect labor is analyzed into several groups such as supervision,

DEPT._____

| | Total | Mon. | Tues. | Wed. | Thurs. | Fri. | Sat. | Total |
|---|---|---|---|---|---|---|---|---|
| MCH. HRS. | | | | | | | | |
| MALE-D. W.-HRS. | | | | | | | | |
| Amt. | | | | | | | | |
| FEMALE-D.W.-HRS. | | | | | | | | |
| Amt. | | | | | | | | |
| MALE-P.W.-HRS. | | | | | | | | |
| Amt. | | | | | | | | |
| FEMALE-P.W.-HRS. | | | | | | | | |
| Amt. | | | | | | | | |
| INDIRECT LABOR | | | | | | | | |
| 1.Superintendence | | | | | | | | |
| 2.Instruction | | | | | | | | |
| 3.Fire Drill | | | | | | | | |
| 4.Power Off | | | | | | | | |
| 5.Mch. Out of Order | | | | | | | | |
| 6.Inventory | | | | | | | | |
| 7.Sweep & Clean | | | | | | | | |
| 8.Oil & Overhaul | | | | | | | | |
| 9.Moving Stock | | | | | | | | |
| 10.Personal Injury | | | | | | | | |
| 11.Wait for Work | | | | | | | | |
| 12.Wait for Stock | | | | | | | | |
| 13.Wait for Tools | | | | | | | | |
| 14.Miscellaneous | | | | | | | | |
| 15.Clerking | | | | | | | | |
| INDIRECT HRS. | | | | | | | | |
| Amt. | | | | | | | | |
| TOTAL HOURS | | | | | | | | |
| TOTAL AMOUNT | | | | | | | | |
| CREDITS | | | | | | | | |
| CLASS "S" HRS. | | | | | | | | |
| Amt. | | | | | | | | |
| SPRINGS - HRS. | | | | | | | | |
| Amt. | | | | | | | | |
| MDSE. - HRS. | | | | | | | | |
| Amt. | | | | | | | | |
| PLANT ORDERS-HRS. | | | | | | | | |
| Amt. | | | | | | | | |
| TOT. CR. HRS. | | | | | | | | |
| TOT. CR. AMT. | | | | | | | | |

PEG BOARD SHEET USED TO DISTRIBUTE PAYROLL
ONE SHEET USED FOR EACH PRODUCTIVE DEPARTMENT.

EXHIBIT 3

instruction, waiting-for-work, sweeping and cleaning, moving of stock, clerical, etc.

The second group I will call our cost summarizing group. When they receive the notice of final shipment they call in the cost analysis copy from the divisional factory clerks, collect partial shipment slips and requisitions for direct supplies and materials and summarize the costs which are then applied to the cost department copy of the sales invoice. This sounds purely routine but these clerks must be very careful to see that the material requisitioned is reasonable as well as to make sure that the order is not confused with another order in the works and many other checks must be made before releasing the cost for final closing and adjusting.

The third division is handled directly by the cost accountant and his assistant. This includes the factory journal through which all tabulations and closing entries are passed and the factory ledger. This factory ledger, in addition to having an account for each burden center, carries a breakdown of sales, cost of sales and work in process for each factory division as well as a breakdown of depreciation allowable for each type of equipment and a complete analysis of selling and administrative expenses.

I think it would be well at this time to explain in detail the ledger sheet we maintain in the factory ledger for each burden center or operating department. The department is charged with direct labor, indirect labor, supplies, repairs, expense on spoiled work, fixed charges and a share of plant general expense. It is then credited with labor and burden absorbed through production and a balance column accumulates the over- or under-absorbed burden. This burden balance is carried along until the end of the year in the factory ledger so that we are given a constant check as to whether we are using too high or too low a rate, but on our statements it is charged or credited monthly to profit and loss account.

*Departmental Burden*

Our factory is broken down into approximately one hundred and fifty operating or burden centers and the composite rates used by the timekeepers in extending the cost of the various operations are furnished by the cost department. On the surface it would appear that we have an unnecessary number of burden rates to figure, but after the system is once operating smoothly additional

departments may be added with very little effort. The more you break down your factory into types and sizes of equipment the more equitable you will find your average labor and burden rate and the less chance of having your foreman come back to you with the complaint that you are charging him too much for certain types of equipment or not enough for others. Our foremen are burden-conscious for they know that any underabsorbed burden is a direct loss to them and if you can satisfy them that the charges to their department are reasonable, they will more than meet you half way when you suggest raising burden rates.

*Cost of Repairs to Products and Returned Goods*

Each department is charged back with the cost of all repairs to product. If the error is located before the goods leave the factory the foreman will make the repairs and charge this excess cost against his own department. He is usually willing to accept this charge because he knows it will come back to him later in the form of a stuck job and he would rather have his job show a profit.

Goods returned by the customer are passed through our complaint department where we decide whether the product should be repaired or whether it would be cheaper to scrap and replace the lot. If the springs are to be repaired, we enter a new production order and return the springs to work in process at the original cost. The foreman will repair the springs on this order number and when the job is costed we will recharge cost of sales with the original cost and charge the repair time to the departmental burden.

Every foreman is able to keep his expenses down to a minimum by a very simple system we installed a few years ago. Miscellaneous repairs performed by our machine room, millwright or electrical department are posted the same as any productive time on order numbers and the following day these postings are returned to the foreman charged with the work and he will make sure he is not being charged too much for the work done. We also return to the foreman the priced requisitions for indirect supplies after they have been tabulated by the cost department.

Plant general expenses are spread to the operating departments on the basis of their ability to absorb these charges. In other

words, we spread these expenses over the total labor (direct and indirect) plus the repair charges of the previous six months.

*Control of Repairs, Replacement and Additions*

Repairs to plant equipment and purchases of new equipment are controlled by means of plant orders which we commonly refer to as "P.O's." These plant orders are issued by our engineering department and any repair item which is estimated to cost over fifteen dollars must be performed on an order. No piece of equipment is permitted to be moved without a plant order regardless of the expense involved.

We maintain a complete record of every piece of equipment in our plant. We use a five by eight sheet for each item and these sheets are filed in a loose leaf visible binder and grouped by operating departments. This system was started a few years back by having one of our men travel through the plant and take an actual physical inventory which was later priced by analysing previous costs and purchase invoices. This record is kept up to date through our present system of plant orders.

The factory journal entries are furnished in condensed form to the chief accountant for entry into the control accounts of the private ledger and balances of both ledgers are compared and balanced monthly.

Selling and administrative expenses are applied to our costs at a percentage to the conversion cost (labor and burden absorbed) on the theory that we are selling the facilities of our plant.

This, then, is our cost system and in addition the following reports are made. Each foreman receives an itemized report of his activities for the month and for his convenience all expenses are broken down to the cost per production hour. We make a monthly report to management breaking down the cost of production into various classifications and make a complete analysis of charges to selling and administrative expenses.

*Summary*

In brief form I would like to summarize our cost system as follows:

Each order is given a separate production number.

Material is charged to the order number for the actual pounds used and priced at the latest average cost as shown on the stock card.

Daywork labor and burden is charged to the cost at an average departmental rate and piecework labor is charged at actual labor cost plus average departmental burden rate.

All production tools are a direct charge to cost.

A cost is applied to every partial shipment which is adjusted to actual cost when the order is completed.

To properly fix and control average burden rates a ledger account is kept for each department in the factory ledger and each department is charged with its share of direct labor, indirect labor, supplies, repairs, depreciation, taxes, insurance and a portion of the plant general expense. Each department is given credit for every productive hour at its average labor and burden rate and a balance column records the amount over- or under-absorbed monthly.

Over- or under-absorbed burden is charged direct to profit and loss.

Selling and administrative expense is added to cost on a percentage to operating or conversion cost.

# PROBLEMS IN COSTING AIRPLANES

**By Leonard C. Mallet, Assistant Secretary and Auditor Sikorsky Aircraft Division of United Aircraft Manufacturing Corp., Bridgeport, Conn.**

BEFORE I GO into some of the detail cost problems encountered in the manufacture of airplanes, I think it would be best if I first mentioned some of the general and broader problems confronting the managements and engineering departments of the individual manufacturers.

## *Use of Productive Capacity*

If the activities of each individual airplane manufacturer in the country from 1925 to 1933 were plotted on one chart, we would find that during any one year there were one, two, or, at the most, three factories operating far in excess of their plant capacities with a resulting loss of efficiency in direct labor, while the others were operating at percentages varying from ten to seventy-five per cent with a resulting high overhead. We would also find that no one company stayed on top for any length of time.

The reason for this continual shifting was that no one company could afford to construct more than one type of airplane at a time. They had either developed and were selling the best airplane available at that time, or they were in the process of developing a new type. They couldn't afford to do both because the cost of development had used all of their resources.. If they were fortunate enough to have developed an airplane of merit with sales possibilities, they constructed and sold as many as possible as quickly as they could because they knew that in a short time a competitor would surely come out with a new type that would make theirs obsolete. If they were extremely fortunate, they sold enough airplanes to pay the expenses of a new development.

This condition naturally reflected itself in the types of costs that were accumulated. Either the company could not afford to spend any money, or it grew up so rapidly that a staff could not be trained quickly enough to accumulate the costs that they would like to have. If they had been fortunate enough to gather some detailed costs, they were valueless by the time they had been

collected because the model on which they had been accumulated had become obsolete and they were working on an entirely new model.

This interesting but unhealthy condition has been remedied somewhat. By the end of 1932 most airlines had sufficient equipment on hand to take care of their immediate needs and no manufacturer had available a model that would make obsolete the equipment they were using. This combination of conditions resulted in a slack period for all manufacturers insofar as sales were concerned. Each manufacturer, however, was experimenting and trying to develop a new airplane that would scoop the market.

By the beginning of 1935 all of the surviving manufacturers had developed their airplanes. Fortunately, each manufacturer had produced a type that served some purpose and the airlines had retired most of their equipment. A deluge of orders came in on practically all airplane manufacturers. Whether we will return to the old system of rotating the leading position in the industry, or to a system where all manufacturers feast and starve at the same time is something that only time will tell.

*Estimating Cost of An Experimental Airplane*

The most difficult cost problem is estimating the cost of an experimental airplane. This is important and difficult because the design and construction of a new type of airplane is expensive and usually different in detail from anything that has previously been built. The simplest way of estimating is on a poundage basis, but this method does not take into consideration the refinements and improved performances of new models. It is, however, a method of checking an estimate quickly. Usually the estimate is based on a three-view drawing and the estimated performances and specifications submitted by the design department and made by the cost department in collaboration with the engineering and manufacturing departments. This data is secured by estimating the cost of each individual section such as wings, tail surfaces, interior, landing gear, etc., using previous experience as a guide, but taking into consideration proposed deviations and improvements such as the tapered wing, retractible landing gear, interior convertible into sleeping accommodations, increased fuel capacity and more advanced types of engines, propellers and instruments.

EXHIBIT 1

WEEKLY LABOR SUMMARY

SERIES 1000

| | Week Ending May 22, 1936 Hours | Week Ending May 22, 1936 Amount | Labor Thru May 22, 1936 Hours | Labor Thru May 22, 1936 Amount | Budget | % of Budget Expended | Prod. Dept. Per Cent Completed |
|---|---|---|---|---|---|---|---|
| Center Section | | | | | | | |
| Tanks | | | | | | | |
| Stabilizer | | | | | | | |
| Elevator | | | | | | | |
| Fin | | | | | | | |
| Rudder | | | | | | | |
| Flaps | | | | | | | |
| Outer Sections | | | | | | | |
| Ailerons | | | | | | | |
| Pontoons | | | | | | | |
| Struts | | | | | | | |
| Engine Units | | | | | | | |
| Gas and Oil Lines | | | | | | | |
| Engine Controls | | | | | | | |
| Flying Controls | | | | | | | |
| Hull | | | | | | | |
| Interior | | | | | | | |
| Beaching Gear | | | | | | | |
| Landing Gear | | | | | | | |
| Instrument Board | | | | | | | |
| Painting | | | | | | | |
| Anodizing | | | | | | | |
| Equipment | | | | | | | |
| Electrical | | | | | | | |
| Assembly | | | | | | | |
| Material Conversion | | | | | | | |
| Cleaning | | | | | | | |
| Engine Repair | | | | | | | |
| Crating | | | | | | | |
| Shop Spoilage | | | | | | | |
| Paid Extras | | | | | | | |
| Unpaid Extras | | | | | | | |
| Dies and Jigs | | | | | | | |
| Total | | | | | | | |
| Mock Up | | | | | | | |
| Models | | | | | | | |
| Exp. and Tests | | | | | | | |
| Rework | | | | | | | |
| Flight Tests | | | | | | | |
| Grand Total | | | | | | | |

This estimate, if approved by the management, is then used as a budget.

*Budgeting Costs*

Experience has shown that the material costs are fairly constant in proportion to the size of the airplane, but that engineering labor and construction labor are the two variables. In conjunction with the engineering department a detailed budget is made for expenses applicable to the design and development of a new project. These details are:

Models
Model tests
Mock up
Experimental
Design Salaries
Stress Salaries
Drafting Salaries
Weight Control Salaries
Material tests
Drop tests
Blueprinting

An analysis is issued monthly showing the charges for the month, the accumulated total, the budget and the per cent of budget expended. The budgeting of the construction labor is a bit more complicated in view of the fact that it is necessary to satisfy both the management and the manufacturing department with the type of reports that are issued.

The total labor allowance is broken down into thirty-seven items as shown in Exhibit 1.

These thirty-seven items are detailed for the management on a weekly report (Exhibit 1) which shows the hours and money expended for the week, the accumulated hours and money spent, the budget, the per cent of budget expended and the estimated per cent completed. This report shows at a glance the detail as well as the total comparison with the budget. The same items are used in a report (Exhibit 2) to the factory in which the budget is broken down over the seven shops and shows the factory manager and the foremen the budgeted hours for each labor group

by shop and the accumulated hours expended by shop. This report does not carry a percentage of completion because it is felt that the individual foremen should be so well acquainted with the details of their departments that they are able to pick out and remedy the items which are showing a tendency to exceed the budget. It is to be understood that these thirty-seven items do not comprise the entire detail accumulated, but are the control groups. There are approximately two thousand individual costs accumulated on an experimental airplane which are built up from detail costs into minor assemblies, major assemblies, and then into the thirty-seven control groups.

EXHIBIT 2

LABOR ANALYSIS
SHOP A
SERIES 1000

| | Hourly Budget | Hours Expended to 5/22/36 |
|---|---|---|
| Center Section | | |
| Tanks | | |
| Stabilizer | | |
| Elevator | | |
| Fin | | |
| Rudder | | |
| Flap | | |
| Outer Sections | | |
| Ailerons | | |
| Pontoons | | |
| Struts | | |
| Engine Units | | |
| Gas and Oil Lines | | |
| Engine Controls | | |
| Flying Controls | | |
| Hull | | |
| Interior | | |
| Landing Gear | | |
| Instruments and Board | | |
| Painting | | |
| Anodizing and Plating | | |
| Equipment | | |
| Electrical | | |
| Assembly | | |
| Paid extras | | |
| Unpaid extras | | |
| Crating | | |
| Spoilage | | |
| Engine repairs | | |
| Cleaning | | |

*Budgeting and Accumulating Costs on Production Models*

The problem of accumulating detailed costs on production models is comparatively simple and not much different from that used in other industries. Estimating the cost of a series of ten, twenty, or fifty airplanes, however, is as difficult a problem as the estimating of an experimental airplane. The industry is not as yet a mechanized one and depends chiefly on experienced hand labor which is not always available. It is necessary that our estimates provide an allowance for the training of inexperienced personnel. This, of course, is rather difficult to estimate and depends entirely on the size of the staff as well as the speed with which an organization increases its factory personnel.

Approximately fifty per cent of the entire labor in fabricating and constructing airplanes is for assembly items. These assembly items are accumulated by ship number and are used as a comparison with similar items on each succeeding airplane in a report (Exhibit 3) to both management and the factory. This report accounts for a high percentage of the entire labor expended, is easily digested, shows the trend in each shop, and is in addition to the two reports mentioned above. All detail work orders, prior to their being issued to the factory, are passed through the cost department for a budget allowance which is based on the cost of the experimental airplane less an allowance for increased quan-

EXHIBIT 3

COMPARATIVE ASSEMBLY HOURS BY SHIPS
SERIES No. 1000
*as at May 22, 1936*

| | 1001 | 1002 | 1003 | 1004 | 1005 | 1006 | 1007 | 1008 | 1009 | 1010 |
|---|---|---|---|---|---|---|---|---|---|---|
| CENTER SECTION | | | | | | | | | | |
| Front spar assembly | | | | | | | | | | |
| Rear spar assembly | | | | | | | | | | |
| Leading edge assembly | | | | | | | | | | |
| Structure assembly | | | | | | | | | | |
| Metal skin— | | | | | | | | | | |
| Prepare and attach. | | | | | | | | | | |
| OUTER SECTION | | | | | | | | | | |
| Front spar assembly | | | | | | | | | | |
| Rear spar assembly | | | | | | | | | | |
| Leading edge assembly | | | | | | | | | | |
| Structure assembly | | | | | | | | | | |
| Metal skin— | | | | | | | | | | |
| Prepare and attach. | | | | | | | | | | |
| Foil | | | | | | | | | | |
| Fabric cover | | | | | | | | | | |
| Dope | | | | | | | | | | |

tity, improved tools and equipment. Approximately six thousand work orders are issued on a series.

From the foregoing it can be seen that budgets or estimates play an important part in our operations. This emphasis on estimating is due not only to our desire to have a budget of our future expenditures, but also to the necessity of estimating the cost of both the experimental and production airplanes in order to set sales prices before the first ship is completed.